REMARKS

This amendment is responsive to the Office Action mailed January 13, 2006. In the Office Action, Claim 39 and dependent Claims 12-18 were allowed. Claims 1-5, 7-10 and 40 were rejected based on prior art. By this amendment, Claim 1 has been canceled without prejudice, and Claims 2-5 and 7-10 have been amended to depend from independent Claim 40. New Claim 41, also dependent on Claim 40, has been added.

Applicants desire to place the application in immediate condition for allowance, and thus request entry of the amendments indicated herein.

The Office Action relied upon Gormish et al. to reject Claim 40. Applicants have amended Claim 40 to more precisely state the claimed subject matter. In particular, Claim 40 recites a method of producing a first plurality of output data values that approximate a linear transform of input data that otherwise result in a second plurality of output data values, "wherein an error difference between the first plurality of output data values and the second plurality of output data values is bounded, the method further comprising determining an order in which to perform the successive combination of steps and determining one or more values to use in the steps to minimize the error difference." Applicants submit that the Gormish et al. reference does not anticipate or render obvious the features recited in Claim 40 and indeed the claim has been placed in immediate condition for allowance.

Regarding Claim 40, the Office Action cited Gormish at page 63, Equation 1 and page 64, Equations 2-4. Neither these Equations nor the corresponding description in Gormish suggest a bounded approximation error that is minimized by determining an order and values to use when generating the output data values.

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The present application, in contrast, undertakes a matrix factorization process that leads to a minimized bounded approximation error. The present application (page 5, lines 16-27) describes the problem as follows:

> For both versions of the problem, the goal is to find an integer bijection φ approximating the given transformation so that the approximation error is bounded over all inputs, preferably with a small bound. (Of course, there are other properties one would like φ to have, such as easy computability of φ and φ^{-1}.) As we will see, this is possible only if the determinant is ± 1 in the fixed-length case; there is a similar restriction in the unbounded-length case. Even then it is not obvious that one can get the error to be bounded. In the fixed-length case, one could try some sort of greedy algorithm which initially maps each point in the first lattice to the nearest point in the second lattice and then goes through a correction process to resolve collisions (two points mapped to the same point) and gaps (points in the second lattice not images of any point in the first lattice), but the corrections might get worse and worse as more points are processed, and it is not at all clear that one can get a bounded-error bijection this way.

To address this problem, the present application (page 6, lines 11-14), describes an underlying "divide and conquer" approach using matrix factorization:

> The main approach we will use for integer approximations is to divide and conquer: if we have a linear transformation with no obvious suitable integer approximation, then we factor the matrix into parts which we do know how to approximate. The composition of these

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approximations of parts will be a suitable approximation to the entire transformation.

Beginning with a 2x2 diagonal matrix (see, in particular, pages 9-16), the application on page 10, lines 9-11 notes:

> Any such factorization leads to a bounded-error integer approximation for D. A plausible choice for r and s would be to "balance" the factors by requiring $|r| = |s\alpha|$, but it is not clear that this will minimize the error bound.

Continuing on, the present application describes an error bound "d" (see top of page 15), and further describes, on page 15, lines 13-19:

> Again consider the example $\alpha = \sqrt{2}$. For (2.1) we have a single error formula and can proceed directly to numerical optimization to find that the best value for r is about 0.5789965414556075, giving an error bound of about 1.9253467944884184. For (2.2), the error bound is the maximum of four separate formulas; it turns out that this is minimized where two of the formulas cross each other, at $r = \sqrt{2\sqrt{2}-2}/2 \approx 0.4550898605622273$,, and the error bound is $\sqrt{12+18\sqrt{2}}/4 \approx 1.5300294956861884$.

After providing an example with a 2x2 matrix and then discussing matrix factorization methods for larger matrices, with various optimization propositions on pages 34, 36, and 39, the present application provides additional considerations, noting on page 41, line 20-page 42, line 4:

> As for the error analysis, even the simple case of a 2 x 2 diagonal matrix was not analyzed completely. In more complicated cases the analysis was quite selective; many variant factorizations remain to be

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examined. And everything was based on the initial assumption that the goal was to minimize the worst-case error in the integer approximation of the transform (and perhaps the inverse transform). Some applications may entail optimizing with respect to some other parameter, in which case different integer approximations may work better.

The order in which computations are performed also provides other advantages. In one example, the order may allow computations to be performed "in place":

> FIGURE 2 illustrates the process followed to generate the elementary matrices, permutation matrices and diagonal matrix used in the present invention...Note that φ can be computed in place (output entries overwriting input entries) if the output entries are computed in the order $y_1, y_2, \ldots, y_n$; φ^{-1} can also be computed in place, with the results computed downward from x_n to x_1.

Applicants submit that Claim 40 is patentable over Gormish et al. Moreover, the articles by Daubechies et al. and Li et al. do not overcome the deficiencies discussed above with respect to Gormish et al. Accordingly, Claim 40 should be allowed.

Claims 2-5 and 7-10, previously dependent on Claim 1, have been amended to depend from independent Claim 40. Claims 2-5 and 7-10 should be allowed, both for their dependence on an allowable base claim and for the additional subject matter recited therein.

Additionally, Claim 41 recites the method of Claim 40, further comprising "preserving a selected property in which $A(k\mathbf{1})=k\mathbf{e}_1$ where A is a matrix providing the linear transform, k is a constant, $\mathbf{1}$ is a vector with all entries equal to 1, and $\mathbf{e}_1$ is an elementary vector with a first entry of 1 and remaining entries of 0." Pages 29 to 30 of the present application describe an example of color conversion from RGB to YC_BC_R. As indicated at page 30, lines 16-19, the application

describes ensuring "that the integer approximation preserves this property", that is, that $A(k\mathbf{1})=k\mathbf{e}_1$. See also "the previous section" on page 27, line 24 to page 29, line 2.

The cited references do not anticipate or render obvious the features recited in Claim 41. Claim 41 should also be allowed, both for its dependence on allowable Claim 40 and for the additional subject matter recited therein.

CONCLUSION

For at least the foregoing reasons, applicants submit that all pending claims are in condition for allowance. Action to that end is requested. Should any issues remain, the Examiner is invited to contact the undersigned attorney by telephone.

Respectfully submitted,

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I hereby certify that this correspondence is being transmitted via facsimile to the U.S. Patent and Trademark Office, Group Art Unit 2625, Examiner Yubin Hung, at facsimile number 571.273.8300 on May 15, 2006.

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